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# MINING AND INDUSTRIALIZATION IN SELECTED AFRICAN COUNTRIES: IMPLICATION OF PUBLIC POLICY ON ENTREPRENEURSHIP PERFOMANCE

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**Abstract**

The effect of mining activities in African countries have a 'Dutch disease' syndrome, which suggests a paradox of growth in such economies. The paper determines whether mining countries are more industrialized than lesser concentrated mining economies in Africa using the measures of a knowledge economy and intuitional entrepreneurship as a proxy for industrialization. However, the specific objective is to determine how mining of precious metals affects the growth of industrialization in selected countries of Africa. To this end, we implore both qualitative and quantitative cross country analysis. We start by grouping the countries within regions into two using cluster analysis. Afterwards, cross country panel estimation was implored to address the question of whether mining contributes to industrialization in Africa. The analysis reveals that all the independent variables used to capture mining fails to exhibit significant impact on industrialization in mining countries; we then conclude that mining does not have significant impact on the industrialization of the countries used during the period under review. The study recommends more affirmative public policy participation in regulating mining activities in African countries through project financing agreements; vertical and horizontal foreign investments arrangements; and through the suggested policy strategies that links mining to industrialization.

**Keywords:** Mining, Industrialization, Entrepreneurship, Policies, Africa

## Introduction

The importance of mining to most African countries cannot be overemphasised as it is the major foreign exchange earner in economies. According to conventional or traditional wisdom, countries that possess rich mineral deposits are fortunate. Such deposits are assets, and so are parts of a country's natural capital. Like an individual or family, the more capital and wealth a nation possesses, the richer and better off it is. In this view of the world, mining is the key that converts dormant mineral wealth into schools, homes, ports, and other forms of capital that directly contribute to economic development (Davis & Tilton, 2015).

The African continent is no doubt endowed with enormous natural resources especially mineral and agricultural resources. The US Geological society ranks Africa as the largest or second-largest reserve of bauxite, cobalt, industrial diamonds, manganese, phosphate rock, platinum group metals and zirconium with the key mineral resources being Precious metals, diamonds and copper (KPMG, 2013). The products produced from these minerals are found in everyday life. To this end, economies heavily rely on the proceeds from mining activities realized from exports and other forms of trade for its economic sustainability growth inclusive. There is widespread agreement that rich mineral deposits provide developing countries with opportunities, which in some instances have been used wisely to promote development, and in other instances have been misused, thereby hurting development.

However, despite the intuitive appeal of the traditional wisdom, a new view of mining has emerged over the past two decades that questions the positive relationship between mineral extraction and economic development. Empirical studies suggesting that countries where mining is important have not progressed as rapidly as other countries provided the initial impetus for the new view. More recent studies have explored the reasons behind the disappointing performance of some mineral producing countries, and have identified the following possible explanations as to why mining may hinder economic development. According to Iimi (2007), resource-rich economies tend to fail in accelerating growth because of various adverse effects of abundant natural resources. In fact, the mineral-dependent nations include some of the poorest and worst performing economies in the world (Roderick, 2014).

The cause of this has been linked to the [1]Dutch disease syndrome in studies linking natural resource richness and economic growth. For instance, Sachs and Warner (1995) confirm that countries with abundant primary resources are likely to grow slowly when initial income levels and differences in macroeconomic policies are controlled. Leite and Weidmann's (1999) evidence also supports the resource curse hypothesis supporting that capital-intensive resource industries tend to induce more corruption, hampering economic development. Papyrakis and Gerlagh (2004), focusing on the transmission channels through which resource richness affects economic growth, show that the indirect, negative effects of policies, such as trade openness and educational investment, outweigh the direct, positive resource effects. The contention between the two schools of thoughts namely, whether or not mining usually promotes industrialization remains unresolved. Hence, this creates a problem for research. Industrialization is a complex process comprised of a number of interrelated dimensions (Hedley 1992). Following the work of Tamuno and Edoumiekumo, (2012), Ibbih and Gaiya, (2013), industrialization explains economic growth. In some cases, the underlying variable upon which these distinctions are based is economic, in other cases it is political, and in still others it is unspecified. In this context, we measure industrialization by total entrepreneurship measure dimension.

For decades, African has produced mineral resources in billions of tonnes, ounces and barrels to other part of the continent and world. Still, there exists billions of more reserves and may be even more with further exploration. It is without doubt that Africa is one the richest part of the world as regards mineral resources and plays host to leading exporting countries in respective resources (Obafemi, 2010). ADB, (2012) affirms that natural resource endowment offer great opportunities for achieving high levels of growth and development, if properly managed. It is however not clear whether resource-rich countries have been able to take full advantage of their potential wealth to promote industrialization, growth and development in reality. The consensus on this issue is important; it means that one uniform policy toward all mining in the developing world is not desirable. The appropriate public policy question is not should we or should we not promote mining in the developing countries, but rather where should we encourage it and how can we ensure that it contributes as much as possible to industrialization. The certainty to curb the illusion is subject to an academic research which this study takes on as its purpose.

**Mining sector in Africa**

The mining sector is an important source of employment, revenues, and demand for local services and goods in the countries in which the mines are located. Commercial mining provides employment and transfers skills to workers and can also be an important source of social services to remote communities. With properly managed environmental, social and corporate governance, these projects can make a significant contribution to sustainable development and poverty reduction in host countries.

[1] Dutch disease has negative effect on growth due to large increases in income common caused by resource endowment.

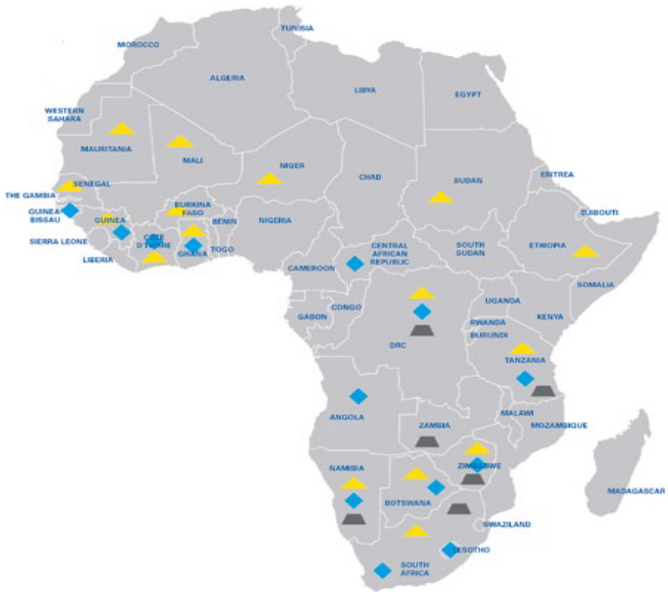


**Figure 1: Key mineral resources in Africa**

**Sources: US Geological Survey,**

The outlook for Africa's mining sector remains bright. Huge tracts of Africa remain largely unexploited. Figure 1 above shows the key mineral resources that expands through the length and breadth of the continent are precious metals, diamonds and copper. Given the high price and rising demand for minerals and metals today, there is vast potential for investors in the sector. But there are inherent risks. While resource-rich countries present significant opportunities, they also pose challenges, not least because of their location in parts of the world with precarious political or socio-economic situations. Weak macroeconomic frameworks and inadequate legal and regulatory regimes often hamper development in these countries. Poverty and growing income disparities can also fuel civil disturbances and conflict. Furthermore, tensions can develop between central and local governments over the distribution of royalties and taxes. And failure to address social and environmental concerns properly can exacerbate tensions with local communities, damage the reputation of project sponsors and lenders, and result in huge losses.

Many governments in promising mining locations are reviewing old agreements and renegotiating contracts for a larger share of the profits. If a host government expropriates a project without paying full and fair compensation, investors can lose massive investments. The trend towards resource nationalism, fuelled by the boom in mineral prices, is another risk factor for investors in the sector. Complexities of this nature fall within the realm of political risks and present significant challenge to mining companies. Given the large capital costs and longer time horizons associated with projects, managing political risks should be a critical part of the global business strategy of mining investors especially with the avalanche of FDI inflows in the mining sector. Amirahmadi and Wu (1994) attributed the cause of the surge of FDI to developing countries as a product of pragmatic paradigm shift in contemporary times for investments, as against the background of parochial '*dependencia*' theory[2]. An overview of Africa's economy between 1980 and 2000 reveals that the flow of foreign direct investment increased significantly due to the availability of natural resources. UNCTAD's FDI data for Africa reveals that the emergence of foreign direct investment is instrumental for engineering capital, technology and skills inflows geared towards economic enhancement through foreign capacities. Wilhelms (1998) classifies the effects of

[2] The dependencia or dependency theory predicts that poor states will remain impoverished while the rich ones remains enriched as a rule.

FDI into three i.e. the dependency[3], the modernisation[4] and the integrative schools of thoughts[5]. All these are component of industrialization; hence we adopt FDI in our estimation. FDI is indeed a desired salutary addition to the economy of virtually all African countries and as such should be harnessed to attract industrialization in Africa.

**Mining risk in Africa**

Apart from the political risk mentioned earlier, mining by its very nature is financially expensive, environmentally invasive and socially intrusive, yet many countries have successfully managed to convert their mineral endowment into national wealth providing the country with the economic means to address its environmental problems and social aspirations. Recently, the mining industries have been experiencing a spate of accidents, intense social conflicts and political debate, in both developed and developing countries which have focused attention not only on the mining industry but on its financiers, investors, lenders and insurers as the costs of mitigating the environmental and social damage can be enormous.

***Financing risk***

The financing of mining and minerals projects is not only important, but is increasingly under scrutiny regardless whether it be debt or equity financing. All financial involvement carries risk and it is the financial institution's skill in identifying and quantifying the different levels of risk that separates good decisions from bad ones. The risk are indeed enormous, however, over the years insurance and project guarantee strategies have been implored by host countries to mitigate the effect of financial and other related risk inherent in mining operations. The Multilateral Investment Guarantee Agency (MIGA) is a member of the World Bank group that promotes foreign investment into developing countries. They help by supporting economic growth, improve standard of living as well as poverty reduction in host countries. MIGA is present in major mining economies in Africa (see Table 1).

**Table 1: Selected Multilateral Investment Guarantee Agency (MIGA) mining projects in Africa**

| Host country | Projects | Guarantee holder (s) | Investor country | Guarantee amount (US$ million) |
|---|---|---|---|---|
| Mozambique | Kenmare Moma Mining Limited: Kenmare Moma Processing Ltd | KfW-Kreditanstalt fur Wiederaufbau | Germany | 12.4 |
| Democratic Rep. of Congo | Anvil Mining Congo. Ltd. | Anvil Mining Ltd., RMB International (Dublin) Limited | Canada, Ireland | 13.6 |
| Tanzania | Kahama Mining Corp. Ltd | Barrick Gold Corp. of Canada | Canada | 56.3 |
| Tanzania | Kahama Mining Corporation Limited | Societe Generale. S.A. | France | 115.8 |
| Zambia | Chambishi Metals Plc | Anglovaal Mining Limited | South Africa | 30.0 |

**Source: MIGA bulletin (2015)**

Environmental, social and increasingly reputational risks are just a few of the many risks to be assessed each time a financial institution gets involved in a business. These risks if not well managed can hamper industrialization. From this point of view, mining risks can be characterized in these two ways:

[3] The Dependency School of Thought explains why international trade promotes exploitation of developing counties by their developed counterpart, in the view of neo-Marxist and Structural theories.

[4] The Modernization School of Thought is of the view FDI as a means implored by developing countries in order to attain higher developmental stages.

[5] The integrative school of thought is a non-traditional way that combines both previous school of thought. It focuses on the receiving nation as well as the investors' perspectives.

***Direct risk***

As countries tighten their environmental regulations and public concern about the mining industry grows, pressures increase on companies to minimize their environmental impacts and pay greater heed to local social issues. This may increase companies' capital and operating costs in order to comply with increased environmental regulations and social expectations. This can have an impact on cash flow and profitability, a borrower's ability to meet loan repayments and the value of the entire operation. It is therefore, important to thoroughly assess environmental performance as part of the normal credit appraisal process.

***Indirect risk***

Legislation differs from country to country but many adopt the 'polluter pays' principle to pollution incidents. Financiers are increasingly concerned to avoid being placed in positions where they might be considered directly responsible for the polluting actions of their clients, in this case mining companies.

**Literature Review**

***Concept of industrialization***

Industrialization is said to be a hallmark for modern economic growth and development (Tamuno & Edoumiekumo, 2012). Since the steam engine powered by coal enhanced and the overwhelming efficiency of mechanized farming, which the industrialization revolution in Great Britain and the world, nations have sought industrialization as a panacea to growth and development. However, there cannot be growth without entrepreneurship and enterprises strive better in an industrialized economy. Industrialization leads the pathway to economic growth and development which can be evidenced by transformations and structural changes from low to high productive economic activities (Ibbih and Gaiya, 2013)Industrialization is the process in which a society or country (or world) transforms itself from a primarily agricultural society into one based on the manufacturing of goods and services. Industrialization describes a complicated process of change. This process has unfolded in a variety of ways across different countries. For instance, during the course of the last century, industrialization has affected the lives of everybody living in Southern Africa shaping the society we live in today. This feature examines the process of industrialization in South Africa as a measure of per capita GDP which indicates standard of living. In this article many aspects of industrialization are discussed that are aimed at making clear what industrialization means. For instance, in the late 19th Century, South Africa changed rapidly from an agricultural society, where most people lived off the land, to an industrial society.

Taking a cue from precedence, the British industrialization involved significant changes in the way that work was performed. For instance, the process of creating a good was divided into simple tasks, each one of them being gradually mechanized in order to boost productivity and thus increase income. However, industrialization also involved the exploitation of new forms of energy. In the pre-industrial economy, most machinery was powered by human muscle, by animals, by wood-burning or by water-power. With industrialization these sources of fuel were replaced with coal, which could deliver significantly more energy than the alternatives. Indeed, much of the new technology that accompanied the industrial revolution was for machines which could be powered by coal. One outcome of this was an increase in the overall amount of energy consumed within the economy - a trend which has continued in all industrialized nations to the present day. This is why we link the measure of industrialization to the indicators adapted from the measures and drivers of knowledge economy, the global entrepreneurship monitor (GEM) and the 2007 state new economic index. The accumulation of capital allowed investments in the scientific conception and application of new technologies, enabling the industrialization process to continue to evolve, and it informs the variables used for statistical analysis in this paper.

**Mining and industrialization in Africa**

It is a well-known fact that the African continent is well endowed with abundant and diverse mineral resources. However, whether this vast wealth of mineral resources has led to the economic transformation in the continent into a more industrialized state over the years is yet to be seen. There is need, therefore, for the African continent to move the

mining industry beyond extracting and exporting raw materials but rather, use the revenue accrued in a strategic process of industrialization and structural transformation.

O'Brien (2001) and Szirmai (2012) define industrialization as a socio-economic process that includes a rise in manufacturing activity in relation to all other forms of production and work undertaken within national economies. It is associated with higher productivity growth and structural economic transformation and development. Many studies have thus attempted to look at whether mineral rich countries have managed to industrialize and the associated reasons behind the success/failure of such an endeavour. This paper joins the attempt to examine this in Africa.

**Industrialisation and economic growth**

The search for the relationship between entrepreneurship and economic growth is not new. Countless theorists, scholars, economics have made significant contributions to the understanding of entrepreneurship and its relations to economic growth. To mention a few, Cantillon, Schumpeter, Kirzner, Knight, Casson, Pinchott, Shane and Venkataraman recognized entrepreneurship as a principal agent of production and industrial progress. One of the pioneer studies addressing the relationship between natural resource richness and economic growth is Sachs and Warner (1995). They find that developing countries with abundant primary resources are likely to grow slowly when initial income levels and differences in macroeconomic policies are controlled. Papyrakis and Gerlagh (2004), focusing on the transmission channels through which resource richness affects economic growth, show that the indirect, negative effects of macroeconomic policies, such as trade openness and educational investment, outweigh the direct, positive resource effects.

Leite and Weidmann's (1999) evidence also supports the resource curse hypothesis. Capital-intensive resource industries tend to induce more corruption, hampering economic development. To the contrary, Auty and Evans (1994) indicate that mineral exports are negatively correlated with growth, but only for the relatively mature mineral based economies and only for certain periods. Theoretically, abundant natural resources could promote growth, because resource richness can give a ''big push'' to the economy through more investment in economic infrastructure and more rapid human capital development. Therefore, any resource-rich country must attain higher growth rates (Sachs and Warner, 1999; and Murphy, Shleifer, and Vishny, 2000). This is evident in the long-term history of resource-rich developed countries, such as Australia, Finland, and the United States (de Ferranti and others, 2001). Various reasons have been put forward for failures to effectively transform natural resources to growth: Dutch disease; insufficient economic diversification; rent seeking and conflicts; corruption and undermined political institutions; overconfidence and loose economic policies; and debt overhang.

However, it cannot be disputed that industrial growth is a pre-requisite for economic growth and development. In this regard, the African continent, which has high indices of poverty and low economic development, needs to pursue rapid industrialisation in order to realise economic transformation. Audretsch and Thurik (2001) assert that, it has been increasingly recognized as a major driving force for innovation and economic growth in all economies. Several studies have found strong correlation between industrialisation and high and sustained economic growth, (Rodrik, 2007; Hasse, 2008, and; Szirmai, 2009). Empirical evidence shows that African leadership[6] adopted the New Partnership for Africans' Development (NEPAD) in 2001, in recognition that economic transformation through industrialisation was an important driver for growth and poverty reduction in Africa, (UNCTAD, 2011). The endogenous growth theory as well as institutional economics also recognises the importance of industrialisation, especially manufacturing, in economic development (Szirmai, 2012. It is in this regard that most African countries have long advocated for industrialisation through economic diversification. The manufacturing sector and small and medium enterprises (SMEs) which constitute a large majority for African enterprises have long been recognised as key drivers for industrialisation. Therefore, it is important for resource-rich countries to improve their systems, technologies and processes in order to utilise natural resources more effectively, thereby promote economic development and growth which implies industrialization (Fu, Pietrobelli and Soete, 2010).

[6] NEPAD is an economic program on development of the African Union established in 2001.

**Linking institutional entrepreneurship to industrialization**

This term institutional entrepreneurship refers to the 'activities of actors who have interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones (Maguire, Hardy & Lawrence, 2004). While the term 'industrialization' refers to a society's increasing use of machinery, technology and automated processes, with this increase usually comes economic growth. The growing recognition of the extent to which institutions determine economic outcomes has been one of the key developments in economic research and policy analysis in the last two decades. At the same time, the entrepreneur has made a comeback, resurrected as one of the prime value creators in society. This comprehensive volume builds on Baumol's 1990 framework to categorize and classify the growing research field that explores the interplay between institutions and entrepreneurship. It also contains the unique feature of examining the ways in which entrepreneurs themselves shape institutions.

Entrepreneurship has been recognizes as an important aspect of an organization and economies (Dickson, Solomon and Weaver, 2008; Ossai and Nwalado, 2012; Arewa, 2004; Akpomi, 2008; Ojeifo; Baba, 2013). For instance, Schumpeter (1984) argued that entrepreneurship is very significant to the growth and development of economies. It contributes in immeasurable ways towards creating new jobs, wealth creation, poverty reduction and income generating for both government and individuals. GEM (2002), shows that the national level of entrepreneurial activity has statistical significant association with subsequent levels of economic growth. Entrepreneurship is driven by the presence of certain factors such as infrastructure and a sound macroeconomic environment which acts as opportunities for growth. Entrepreneurship creates and exploits opportunities that brings about change while entrepreneurs are more prone to embrace possibilities created by change rather than problems (Drucker, 1985). This emphasis that the entrepreneur always searches for change, responds to it, and exploits it as an opportunity. Stevenson (1990) adds resourcefulness to the opportunity-based quality off an entrepreneur. However, entrepreneurs or entrepreneurship activities are opportunity seeking in this case mining activities is a source of opportunity for growth and industrialization in their host countries.

There are various strands in the empirical literature between the two using different measures of entrepreneurial activity. For instance, while one strand of empirical studies measures entrepreneurship in terms of the relative share of economic activity accounted for by small firms, other studies use data on self-employment, the number of market participants (competition) or firm start-ups as an indicator of entrepreneurial activities. We acknowledge that there are wide variety of institutions, it is not our intention to jump into the ocean of definition of institution. The term institutions can mean agencies or established organizations, yet the meaning used in determining the level of entrepreneurship includes formal institutions such as the government legislation and public policies. We focus on institutional entrepreneurship; the term is used in determining the level of entrepreneurship.

This makes a case for an entrepreneurship led industrialization growth, wealth creation, income generation, increased output as well unemployment reduction in economies (Obstfeld 1998); Gouriinchas and Jeanne (2003); Prasad, Roggoff, Wei and Kose (2004); Klein, Olofin and Afangideh (2008). To this end, we measure industrialization using the full indicators of entrepreneurship activities as measured by the Global Entrepreneurship Monitor (GEM) and the knowledge economy indicators[7]. However, we adopt specific total entrepreneurship activities (TEA) for the study using OECD indicators in Ahmad and Hoffman (2007) along with some indicators of GEM and knowledge economy. From the study, we adopt the cardinal points for measuring entrepreneurship as: the determinant of entrepreneurship, the entrepreneurship performance and entrepreneurship impact.

**Review of industrial performance in Africa**

Ibbih, and Gaiya, (2013) performed a cross sectional analysis of industrialisation in Africa The industrial performance in Africa has not been encouraging. Measured in terms of the industry value added (IVA) and manufacturing value added (MVZ) in GDP, the trend reveals that the industrial sector has not been significant in contributing to economic growth and development in the African continent. Therefore, Africa has failed to use industrialisation effectively to promote economic growth and development due to public policy failure. According to Ibbih and Gaiya (2013), reveal that industrial value added in the northern African region was a bit encouraging at 40 percent of GDP, whereas IVA in the

[7] A knowledge economy is an economy driven by science and technology in the pursuit of innovation.

sub-Saharan Africa region remains at about 30 percent of GDP. Nonetheless, Ibbih and Gaiya (2013), also note that MVA, which is considered a crucial factor for economic growth has never been satisfactory as it remained less than 20 percent, in the whole the African continent. Given the abundance of natural resources, especially mineral and agricultural resources, UNCTAD (2011) notes that Africa is unable to derive maximum benefits from these abundant resources. This is because the continent is heavily dependent on exports of primary commodities and minerals, which give rise to high, rather than sustained growth rates. Africa's industrial performance has been eroding over the years with MVA estimated at US$54 billion in SSA, compared to US$210 in South and Central Asia between 1990 and 2010 (IDR, 2011).

**The role of industrial policy in economic development**

Given the importance of industrialisation in economic development already alluded to above, many individual countries as well as at the sub regional and the national levels have introduced policy initiatives aimed at promoting industrialisation. For instance, at the regional level, SADC[8] adopted the Industrialization Strategy and Roadmap 2015 – 2063, which is an inclusive strategy comprising of SADC member states as well as other strategic partners, private sector and non-state actors. At the individual level, countries like Egypt, Kenya, Namibia, Nigeria and Uganda have also integrated industrialisation as a key component in their national development plans, (UNCTAD, 2011).

**Methodology**

There are two main objectives of this paper. One is to classify a sample of African countries comprising of a group of mining countries and another group of non mining of precious metals using a mixed qualitative approach. The selected countries were derived from a list of mining economies in Africa as seen in Figure 1. The two groups used in the cluster analysis were simultaneously derived from four parts of Africa, namely Northern, Southern, Western and eastern part of the continent. Using the characteristics of institutional entrepreneurship and indicators of knowledge economies as a proxy for industrialization, we determine which group is industrialization enhancing and which is industrialization inhibiting using Hierarchical agglomerative cluster with squared Euclidean distance to classify eight countries into two cluster solution based on data for 2013.

The second objective is to determine how mining of precious metals affects the growth of industrialization measures in selected countries of Africa using a quantitative approach. Our baseline model will be as follows:

$$K = f(G) \quad (1)$$

where: K = Total Entrepreneurship Activities (TEA)

TEA = Summation of Venture capital + High tech export + per capita GDP

TEA = Level of industrialization

G = Vector of explainable variables reflecting industrialization

Using a regression equation as stated below:

$$Y_{it} = \alpha Y_{it-1} + \beta(L)X_{it} + \mu_i + \varepsilon_{it}, \ |\alpha| < 1, i - 1, \dots, N; t = 1, \dots, T \quad (2)$$

where $Y_{it}$ is the dependent variable representing industrialization indicators, $\beta(L)$ is the $1 * k$ lag polynomial vector, $X_{it}$ is the $k * 1$ vector of explanatory variables other than the $Y_{it-1}$ , $t$ is time, $i$ is the cross sectional dimension respectively, $\mu_i$ is the unobserved heterogeneity (effects on industrialization) and $\varepsilon_{it}$ is the error term. We apply first the difference transformation of equation 2 as:

$$\Delta Y_{it} = \alpha \Delta Y_{it-1} + \beta(L)\Delta X_{it} + \Delta \varepsilon_{it}, \quad (3)$$

With $\Delta$ as the first difference operator.

Equation 4 takes the following variables:

[8] SADC- Southern African Development Community

$$\Delta IDZ_{it} = \propto \Delta ID_{it-1} + \sum_{j=1}^{2} \beta_{1j} \Delta MVZ_{t-j} + \sum_{j=1}^{2} \beta_{2j} \Delta TOP + \sum_{j=1}^{2} \beta_{3j} \Delta ST + \mu_i + \Delta \varepsilon_{it} \quad (4)$$

Where, $\Delta ID_t$ is the first difference of industrialization, $\Delta MVZ_t$ is manufacturing added value, $\Delta TOP_t$ is trade openness, $\Delta ST_t$ is science and technical researchers.

**Sample**

The population for this study is the entire list of countries which make up the continent of Africa. The sample was purposefully selected from the four geo political regions of Africa. Specifically South Africa from the Southern African region; Sudan from the Northern African region, Tanzania from the Eastern African region; and Ivory Coast from the Western African region using mining of precious metals (as presented in Figure 1) for the selection. The selection was as homogenous as possible (see Table 2).

**Table 2: Homogeneity of mining and non mining precious metals countries in Africa**

| | Africa regions | Country | Mining of Precious metals[9] | *GDP as per 2016 estimate | Year of independence | Colonial master |
|---|---|---|---|---|---|---|
| 1 | Southern | South Africa | Yes | $742.4 billion | 1910 (1931) | UK |
| | | Mozambique | No | $36.92 billion | 1975 | Portugal |
| 2 | Northern | Sudan | Yes | $179.5 billion | 1956 | UK & Egypt |
| | | Egypt | No | $1.047 trillion | 1922 | UK |
| 3 | Eastern | Tanzania | Yes | $149.8 billion | 1961 | UK |
| | | Kenya | No | $143.1 billion | 1963 | UK |
| 4 | Western | Ivory Coast | Yes | $85.3 billion | 1960 | France |
| | | Nigeria | No | $1.2 trillion | 1960 | Britain |

***Represents total GDP (Purchasing Power Parity)**

**Variables**

The indicators used are adopted from the measures and drivers of knowledge economy, the global entrepreneurship monitor (GEM) and the 2007 state new economic index to collect the evidence of industrialization. The categories used to determine industrialization are globalization, knowledge jobs, economic dynamics, digital economy and technology innovation as previously used in studies (Allen, 2001; Atkinson & Correa, 2007; Saisana & Munda, 2007; Murdock, 2009). Given certain peculiarities in Africa bordering on insufficient data, lack of contemporaneous data in some instances, and because most countries were found ranking low on innovation criteria. We were limited to venture capital, hig h tech export; per capita GDP and science and technology researchers as the measure of industrialization based on the categories, while manufacturing value added; trade openness; and science and technology researchers were used as the explainable variable of industrialization. Data was sourced from the World Bank and IMF, over a period of 15 years i.e. from 2000 to 2014.

These variables historically, represent a transition from an economy based on agriculture to one in which manufacturing represents the principal means of subsistence. Consequently, two dimensions of industrialization are the work that people do for a living (economic activity) and the actual goods they produce (economic output). Other dimensions include the manner in which economic activity is organized (organization), the energy or power source used (mechanization), and the systematic methods and innovative practices employed to accomplish work (technology) (Hedley, 1992).

[9] Precious metal are rare metals of high economic value such as gold, silver, and platinum

## Results and Interpretations

### *Cluster analysis* (mixed qualitative approach)

Hierarchical cluster analysis with Ward's method of clustering algorithm separated the sample countries based on the variable described earlier, and specifying two cluster solutions. The aim of using the cluster analysis is to combine variables to form groups in which the characteristics of the variable are as homogeneous as possible while ensuring that the characteristics of variable between groups are as dissimilar as possible. The clustered are as follows: South Africa, Sudan, Tanzania and Ivory Coast are classified into the group of countries involved in mining of special metals (group 1). Mozambique, Egypt, Kenya and Nigeria are classified into another group depicting non-mining of precious metals countries (group 2).

The dicriminant function analysis using the all the variables mentioned earlier as predictors of industrialization were performed. A single disciminant function was calculated which was statistically reliable at $p < .05$ and accounted for more than 90% of the variability between the groups. The discriminant function separates the two groupings of economies presumably based on the comparison of the group centroids. All 100% of the original grouped cases were correctly classified except Venture capital investment and trade openness which showed significant univiriate Fs for group difference. High-tech export (.720), GDP per capita (.661), science and technical research (.497) and manufacturing value added (.486) were the most discriminating variables for distinguishing between the two groupings of countries. Table 3 below shows that group 1 being the countries involved in the mining of precious metals are has higher mean values of trade openness and venture capital investment corresponding lower F values than the second group. This signifies that the mining countries have performed better than the non mining countries only in the two measures capable of enhancing industrialization, while the other measures of industrialization have not shown significant *F*s in mining countries.

**Table 3: Discriminating variables**

| | Group 1 | Group 2 | F |
|---|---|---|---|
| | Mean | Mean | |
| Trade Openness | 1205256096305031200 0.000 | 8289812082819517400.000 | 1.454 |
| Science Technical research | 9480137.161 | 18144959.599 | .522 |
| Manufacturing value added | 2788031557649541400 00.000 | 5071449274704205600 00.000 | .550 |
| Venture capital investment | 9695922751630372000 00000.000 | 2744402930011724600000.000 | 353.298 |
| High tech Export | 94158109482046976.000 | 665451107155886340.000 | .141 |
| GDP per capita | 1005109.568 | 4723809.453 | .213 |

### **Panel data analysis** (quantitative approach)

The data of the four countries on all the variables are pooled together and the panel analysis is done under this section. Both static panel models that is fixed and random effects are used in the study. This is to enable the analysis come up with estimates that are consistent. Notwithstanding, a number of diagnostic test are also run. Firstly, the hausman test is performed to know which of the fixed or random effects estimates is appropriate for the study. Secondly, cross sectional dependency test (pool-ability test) is also run to identify the existence or otherwise of cross sectional specific factors in the panel models.

The analysis begins with the estimation and interpretation of the Static panel models which comprise of both the fixed and random effects. Tables 4 and 5 contain the estimated fixed effect within regression and random effects regression results respectively. The first thing we observed there is no much difference between the results of the fixed effects and the random effect but notwithstanding, we go ahead to conduct the hausman test to enable us determine which of the two result we should stick to.

**Table 4: Fixed Effects (within variation regression) Estimation Results for the four countries**

| Variables | Coefficient | Standard error |
|---|---|---|
| TOP | 2.317989 | 14.08972 |
| S&T | -9573934 | 3.01e+07 |
| MVA | 5.829377 | 6.478817 |
| CONSTANT | 1.66e+11** | 5.34e+10 |

***Note: Standard errors in parentheses***

*$R^2$ = 0.0226 (within) $R^2$ = 0.0472 (overall) F(3,53) = 0.41 Prob > F 0.7475*

** statistical significance at 10%** statistical significance at 5%.** *statistical significance at 1%*

*Source: Authors Computation*

**Table 5: Random Effects Estimation Results for the four countries**

| Variables | Coefficient | Standard error |
|---|---|---|
| TOP | -50.07436 | 31.92286 |
| S&T | -2.96e+07 | 7.00e+07 |
| MVA | 5.135994 | 11.77532 |
| CONSTANT | 3.06e+11 | 6.49e+10 |

*$R^2$ = 0.0019 (within) $R^2$ = 0.0989 (overall) Wald chi2(3) = 6.15 Prob > chi2= 0.1047*

** statistical significance at 10%** statistical significance at 5%.** *statistical significance at 1%*

*Source: Authors Computation*

***Hauman test for panel models***

Despite the similarities in the estimated results from the two panel models, yet there are slight differences. Therefore, the next analysis test which of the two models is more appropriate for our analysis. This is done through the hausman test. The result of the hausman test is presented in table 6.

**Table 6: Results of the Hausman test for the panel models**

| Variables | Coefficient fixed B | Coefficient Random B | Difference (b-B) | Standard error |
|---|---|---|---|---|
| TOP | 2.317989 | -50.07436 | 52.39235 | 9.030235 |
| S&T | -9573934 | -2.96e+07 | 2.01e+07 | 1.17e+07 |
| MVA | 5.829377 | 5.135994 | .6933836 | 9.698217 |

Test: Ho: difference in coefficients not systematic

chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 2.94,Prob>chi2 = 0.0863

The results from the hausman test suggest we accept the null hypothesis and reject the alternative hypothesis. The implication of this is that we accept the results from the random effect and reject fixed effects results. Therefore random effect result is more suitable for our analysis. Hence, the few places where we noticed slight differences in the results of the model means we stick with the outcomes of the random effect.

The result from the two panel model results is that all the independent variables fail to have individual significant impact on industrialization. Only the constant has significant impact. The implication is that other factors or variables not captured in the model are likely going to be responsible for the growth of industrialization in the four countries. The random effect result shows overall R square of 0.0989 which is an indication that the independent variables used to capture mining only explained about 9% systemic variation in industrialization. This further justifies why none of the independent variables has individual significant impact on industrialization in the four countries. Again, to further corroborate our findings, the test of overall significance through the Wald test shows that the model fails the test of overall

significance. The implication is that mining is not strong enough to exert significant impact on industrialization in the four countries.

However, the constant is the only variable that is significant, apart from showing that other extraneous factor or variables that are not included in the model might have been responsible for growth of industrialization in these four countries, it also shows that the four countries might possess some individual special characteristics that might distinguish them from one another in terms of the impact of mining on industrialization. This prompts the pool-ability test, which will enable us find out if countries individual cross-sectional characteristics can affect the panel result. This test is also known as cross-sectional dependence test which is presented in table 4.

***Cross-sectional dependence test***

As earlier stated in the introductory aspect of this chapter that a host of diagnostic test will be conducted this includes the test for cross sectional dependence. This is the next test to be explored here. The reason for this is to test whether specific characteristics of individual country can interfere with our panel results. This is necessary as it will enable us determine if we can generalize our results for all the four countries used in the study. This test is done through fixed effect least square dummy variable LSDV. The result is presented in table 7.

**Table 7: Least Square Dummy Variable LSDV Estimation Results for the four countries**

| Variables | Coefficient | Standard error |
|---|---|---|
| TOP | 2.317989 | 14.08972 |
| S&T | -9573934 | 3.01e+07 |
| MVA | 5.829377 | 6.478817 |
| Country 2 | -9.16e+11*** | 1.60e+11 |
| 3 | -8.06e+11*** | 5.90e+10 |
| 4 | -7.99e+11*** | 5.83e+10 |
| CONSTANT | 7.96e+11*** | 4.31e+10 |

***Note: Standard errors in parentheses***
*$R^2$ = 0.0226 (within) $R^2$ = 0.0472 (overall) F(3,53) = 0.41 Prob > F 0.7475*
** statistical significance at 10%** statistical significance at 5%.** *statistical significance at 1%*
***Source: Authors Computation***

The results of the LSDV estimation show individual intercept of the countries are all statistically significant at 1%. This implies the dominance of the specific characteristics of each of the country. As earlier posited this might have accounted for the significance of the constant in the panel estimation. Furthermore the result shows that each of the country South Africa, Ivory Coast, Sudan and Tanzania possess salient feature that distinguish them from one another in terms of the impacts of mining on industrialization.

**Conclusions**

From the analysis**,** all the independent variables used to capture mining fails to exhibit significant impact on industrialization during the period under review. The result is corroborated by the values of the R square which is very low and the model also failed to pass the test of overall significance. Therefore, we can conclude that mining does not have significant impact on the industrialization of the four countries during the period under review.
Again the pool-ability test shows that each of the country might possess some salient characteristics that distinguish them from one another. This characteristic has been shown by the analysis to have significant influence on our result. In other worlds, these differences might affect our conclusion about the impact of mining on the industrialization of the four countries. Consequently, this is an area for further research, that is based on the findings from this research work, other researcher can now try to investigate the impact of mining on industrialization of the these four countries individually.

**Policy recommendations**

***Mining policies focus and industrialization: The suggested link***

***Employment generation and growth***

This can be made possible through the provision of financial resources to host countries by foreign investors. Mining creates employment opportunities to curb the ravaging effects of less productivity of labour while contributing to an ultimate economic growth. Also, mining acts as economic catalyst for enhancing increased linkages of domestic firms for capacity augmentation. For instance potential investors in Kenya have to take into consideration the projected economic benefit of their investment because such requirements are one of the stringent procedures for foreign investors' entrant.

***Supplementing domestic savings***

The mobilization of financial resources, high volatility of short-term and the low share of Africa in world trade has always been an inherent problem in Africa. Given that the flows of financial aids are unpredictable; this impediment makes it difficult to finance growth and development. In recent times, investment increases domestic savings by providing additional capital supply through initial cash flows and retained profits (Makola, 2003).

***Integration into the global economy***

With the aid of market seeking foreign investors in the mining sector in particular, the market efficiencies and better access to both local and international markets enhances regional integration of markets union which ultimately delivers on the global economy. International trade promotes openness and the integration of the mining host-country into the world economies (Morrisset, 2000).

***Transfer of modern technologies***

In the cause of mining, technologies found lacking in African are introduced in productions from the investor countries. Obviously, these technologies are superior and state-of–the-art in operations and design respectively, relative to firms in developing countries. Results from pooled regression on the growth of total factor productivity in Akinlo (2006) reveals that such investment is a channel for transferring foreign technology.

***Raising skills of local manpower***

Since mining activities comes with employment opportunity, it avails the local labour force an opportunity to learn new skills on the job, i.e. on-the –job –training. It enhances local manpower productivity which results in increased outcomes.

*Enhanced efficiency*

Over time, mining activities increases the input of performances through skilfulness in management, effort and time which leads to great competence of outputs. It paves way for business facilitation in the area of investments and cost; incentives, social amenities and a good quality of life.

**Mining and industrialization: The requirements**

What brings about industrialization is a question best answered by the role of the host countries' strategies in promoting mining activities. According to the World Association for Investment Agency (WAIPA)[10] criterion which was created to partner with other agencies to assist in developing countries through investments and to overcome development

[10] WAIPA is an international Non-governmental organization established in 1995 by the United Nations Conference on Trade and Development that acts as a forum for investment promotion agencies (IPA), provides networking and promotes best practice in investment promotion

challenges. The importance of WAIPA criteria is of relevance to what brings industrialization to mining economies in Africa, WAIPA list ten (10) criteria favourable for investments, they are: political stability; domestic economic strength; a welcoming attitude; policies on foreign equity ownership; liberal exchange controls; stable labour force, efficient banking; efficient bureaucracy, sound infrastructure; and acceptable quality of life. These criteria describes what promotes industrialization, hence this should be the focus of public policies in African economies.

In addition to the suggested recommendation on the link between mining policy and industrialization earlier stated in this paper, project finance strategies should also be adopted in African countries in order to manage mining activities. The use of project finance as an investment tool for economic development is gaining popularity among many economies world-wide. Project financing is a structure that relies on future cash flow from a specific development as the primary source of repayment with that development‘s assets, rights, and interests legally held as senior legal collateral security (Harvey, 1983). Project finance is widely used in the investment of natural resources and infrastructure sectors such as power plants, toll roads, mines, pipelines, and telecommunications systems (Esty, 2002). Capital-intensive techniques such as mining and metals. The purpose is to transfer some of the risks associated with this kind of projects from the borrower to the project sponsors. In this case, the project itself remains a borrower of record and hence the countries can still pursue other investment opportunities without the debt affecting the economy. Project finance is gaining support over conventional corporate finance because of its ability to increase the availability of finance as well as to reduce risk among project participants into acceptable levels (IFC Report, 1999). Another impetus which has led to project finance gaining popularity is greater focus on the private sector rather than government to provide funding for investments in form of public private partnerships (IFC report, 1999). If this strategy is inculcated in financing mining activities in Africa this could perhaps deliver on industrialization.

The benefits each offers, and the manner in which each interacts with the host economy differs. For instance the new trade theory classifies foreign direct investment specifically into two categories i.e. vertical and horizontal investments. The vertical is factor intensity conscious; this helps to determine the stages of production, while the horizontal locates in host countries that are close final markets. These two types of FDIs explains Schmitz and Helmberger (1970) and Vernon (1966) findings on how such investment may induce increased export and manufacturing value added among other indicators of industrialization.

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## APPENDIX

### Cluster analysis result

**Case Processing Summary**[a]

| Cases | | | | | |
|---|---|---|---|---|---|
| Valid | | Missing | | Total | |
| N | Percent | N | Percent | N | Percent |
| 8 | 100.0 | 0 | .0 | 8 | 100.0 |

a. Ward Linkage

**Proximity Matrix**

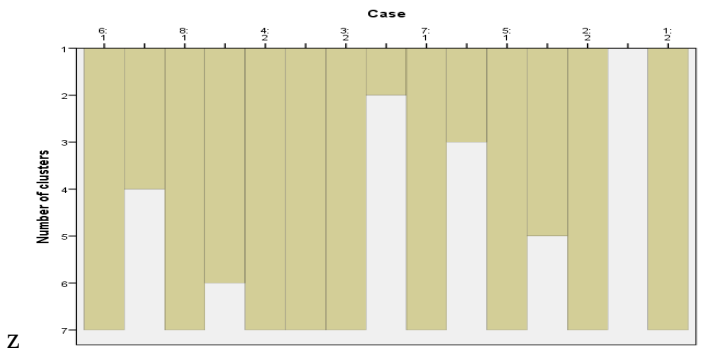
| Case | Squared Euclidean Distance | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1: 2 | 2: 2 | 3: 2 | 4: 2 | 5: 1 | 6: 1 | 7: 1 | 8: 1 |
| 1: 2 | .000 | 1056454289179301300000000.000 | 1181920293589659700000000.000 | 1181404213150804600000000.000 | 1057518762700081700000000.000 | 1201634838908525600000000.000 | 913471046632595600000000.000 | 118622537486606190000000.000 |
| 2: 2 | 1056454289179301300000000.000 | .000 | 5128760493403891000000.000 | 5280253010789444000000.000 | 1794229874928 5632000.000 | 6560186344047538000000.000 | 5268952307690647000000.000 | 5337155985605391000000.000 |
| 3: 2 | 1181920293589659700000000.000 | 5128760493403891000000.000 | .000 | 5724507931416658900.000 | 5238383003193480000000.000 | 1209256237135 19120000.000 | 1936696259471 7190000000.000 | 6117664477414756400.000 |
| 4: 2 | 1181404213150804600000000.000 | 5280253010789444000000.000 | 5724507931416658900.000 | .000 | 5403976705945784000000.000 | 1089651957878 76350000.000 | 1950820036374 4096000000.000 | 1703938119738 7674000.000 |
| 5: 1 | 1057518762700081700000000.000 | 1794229874928 5632000.000 | 5238383003193480000000.000 | 5403976705945784000000.000 | .000 | 6707854689953464000000.000 | 5297957721265632000000.000 | 5434946096006231000000.000 |
| 6: 1 | 1201634838908525600000000.000 | 6560186344047538000000.000 | 1209256237135 19120000.000 | 1089651957878 76350000.000 | 6707854689953464000000.000 | .000 | 2217597971037 2932000000.000 | 1098135869834 93260000.000 |
| 7: 1 | 913471046632595600000000.000 | 5268952307690647000000.000 | 1936696259471 7190000000.000 | 1950820036374 4096000000.000 | 5297957721265632000000.000 | 2217597971037 2932000000.000 | .000 | 1984503378265 4798000000.000 |
| 8: 1 | 118622537486606190000000.000 | 5337155985605391000000.000 | 6117664477414756400.000 | 1703938119738 7674000.000 | 5434946096006231000000.000 | 1098135869834 93260000.000 | 1984503378265 4798000000.000 | .000 |

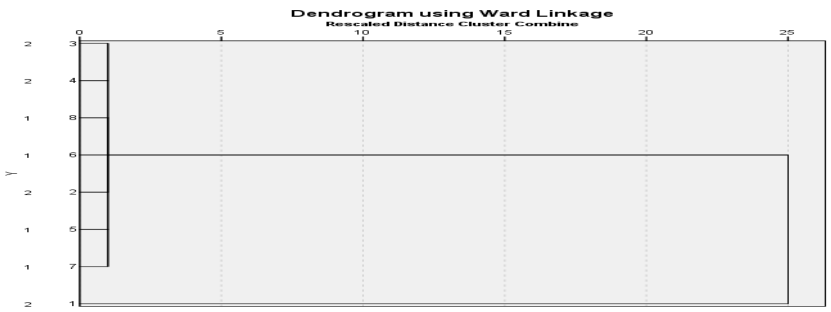
**This is a dissimilarity matrix**

### Ward Linkage

**Agglomeration Schedule**

| Stage | Cluster Combined | | Coefficients | Stage Cluster First Appears | | Next Stage |
|---|---|---|---|---|---|---|
| | Cluster 1 | Cluster 2 | | Cluster 1 | Cluster 2 | |
| 1 | 3 | 4 | 2862253965708329500.000 | 0 | 0 | 2 |
| 2 | 3 | 8 | 9627184535406363000.000 | 1 | 0 | 4 |
| 3 | 2 | 5 | 1859833391004 9178000.000 | 0 | 0 | 5 |
| 4 | 3 | 6 | 1011176393974 19760000.000 | 2 | 0 | 6 |
| 5 | 2 | 7 | 3620430599257965000000.000 | 3 | 0 | 6 |
| 6 | 2 | 3 | 1956301872403 2983000000.000 | 5 | 4 | 7 |
| 7 | 1 | 2 | 9894462437619 07700000000.000 | 0 | 6 | 0 |




**Quick Cluster**

| **Initial Cluster Centers** | | |
|---|---|---|
| | Cluster | |
| | 1 | 2 |
| | | |
| Trade Openness | 407476278.300000000000 | 6697422432.000000000000 |
| Science Technical Research | 169.200000000000 | 67.800000000000 |
| Manufacturing value added | 3974147111.000000000000 | 1381588239.000000000000 |
| Venture capital investment | 1100450000000.000000000000 | 4280053161.999999000000 |
| High tech Export | 38666706.000000000000 | 80780608.000000000000 |
| GDP per capita | 1447.222821000000 | 605.234444700000 |

| **ANOVA** | | | | | | |
|---|---|---|---|---|---|---|
| | Cluster | | Error | | | |
| | Mean Square | df | Mean Square | df | F | Sig. |
| Country | 14.000 | 1 | 4.667 | 6 | 3.000 | .134 |
| Trade Openness | 1205256096305 0312000.000 | 1 | 8289812082819517400 .000 | 6 | 1.454 | .273 |
| Science Technical Research | 9480137.161 | 1 | 18144959.599 | 6 | .522 | .497 |
| Manufacturing value added | 2788031557649 54140000.000 | 1 | 5071449274704205600 00.000 | 6 | .550 | .486 |
| Venture capital investment | 9695922751630 37200000000.00 0 | 1 | 2744402930011724600 000.000 | 6 | 353.29 8 | .000 |
| High tech Export | 9415810948204 6976.000 | 1 | 665451107155886340. 000 | 6 | .141 | .720 |
| GDP per capita | 1005109.568 | 1 | 4723809.453 | 6 | .213 | .661 |

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

**Distances between Final Cluster Centers**

| Cluster | 1 | 2 |
|---|---|---|
| 1 | | 1052823808370.544 |
| 2 | 1052823808370.544 | |

**Iteration Historya**

| Iteration | Change in Cluster Centers | |
|---|---|---|
| | 1 | 2 |
| 1 | .000 | 48137758311.546 |
| 2 | .000 | .000 |

| | Cluster | |
|---|---|---|
| | 1 | 2 |
| | | |
| Trade Openness | 407476278.300000000000 | 4118858148.485714400000 |
| Science Technical Research | 169.200000000000 | 3460.771428571428 |
| Manufacturing value added | 3974147111.000000000000 | 21824418201.857143000000 |
| Venture capital investment | 1100450000000.000000000000 | 47784118853.857140000000 |
| High tech Export | 38666706.000000000000 | 366705222.000000000000 |
| GDP per capita | 1447.222821000000 | 2518.995487485714 |